

Response to the PCT Written Opinion

1) The following opinions were expressed in the Response dated February 1, 2005 issued by the PCT International Searching Authority.

Incidentally, the cited documents are the following Documents 1 to 8.

Document 1: JP2002-105552

Document 2: JP4-358030

Document 3: JP7-316681

Document 4: JP2003-193150

Document 5: JP4-99829

Document 6: JP2000-345252

Document 7: JP2002-206103

Document 8: JP2003-306728

A) The invention pertaining to claims 1 to 4 lacks novelty since Document 7 describes the same purity and impurities as the present invention.

B) The invention pertaining to claims 1 to 4 lacks inventive step based on Documents 1 to 8.

As the reason for this, the Examiner is stating that Documents 1 to 3 and 7 describe the implementation of electron beam melting for reducing oxygen upon manufacturing high purity hafnium. Further, as described in Documents 4 to 6, it is public knowledge to perform deoxidation with molten salt for reducing oxygen in titanium, and, since titanium, zirconium and hafnium have extremely similar physical and chemical characteristics, it would be easy for those skilled in the art to add the process of deoxidation with molten salt for reducing oxygen to the manufacture of high purity hafnium described in Documents 1 to 3 and 7 so as to achieve an oxygen content of 40wtppm or less. Document 8 describes the use of solvent extraction in the refining of hafnium, and this is also public knowledge. Further, the amount of oxygen and impurities is also described in Document 7, and is not exceptional.

C) The invention of claims 5 and 6 lacks inventive step based on Documents 1 to 8.

As the reason for this, the Examiner is stating that Documents 1 to 3 and 7 describe the implementation of electron beam melting for reducing oxygen upon manufacturing high purity hafnium. Further, as described in Documents 4 to 6, it is public knowledge to perform deoxidation with molten salt for reducing oxygen in titanium, and, since titanium, zirconium and hafnium have extremely similar physical

and chemical characteristics, it would be easy for those skilled in the art to add the process of deoxidation with molten salt for reducing oxygen to the manufacture of high purity hafnium described in Documents 1 to 3 and 7. Document 8 describes the use of solvent extraction in the refining of hafnium, and this is also public knowledge.

2) Further, the foregoing Response issued by the PCT International Searching Authority also stated that it is unclear as to whether the invention pertaining to claims 1 to 4 is an invention of high purity hafnium, an invention of a target or an invention of a thin film (inappropriate description).

3) Applicant amended the claims since they were described in a somewhat broad sense by limiting the scope thereof in the Amendments dated the same date (indicated once again below for ease of reference).

Therefore, grounds for the lack of novelty and inventive step have all been overcome, and the inappropriate descriptions have also been corrected. Therefore, the present invention possesses patentability. The reasons for this are described in detail below.

(Claims)

[1] (Amended) High purity hafnium having a purity of 4N or higher excluding zirconium and gas components, an oxygen content of 40wtppm or less, and in which the content of sulfur and phosphorus is respectively 10wtppm or less and the zirconium content is 0.1wt% or lower.

[2] (Amended) A target formed from high purity hafnium having a purity of 4N or higher excluding zirconium and gas components, an oxygen content of 40wtppm or less, and in which the content of sulfur and phosphorus is respectively 10wtppm or less and the zirconium content is 0.1wt% or lower.

[3] (Amended) A thin film formed using the target formed from high purity hafnium having a purity of 4N or higher excluding zirconium and gas components, an oxygen content of 40wtppm or less, and in which the content of sulfur and phosphorus is respectively 10wtppm or less and the zirconium content is 0.1wt% or lower.

[4] (Deleted)

[5] (Amended) A manufacturing method of high purity hafnium wherein a hafnium sponge raw material is subject to solvent extraction and thereafter dissolved, the obtained hafnium ingot is further subject to deoxidation with molten salt, and then

additionally subject to electron beam melting.

[6] (Deleted)

(Incidentally, the underlined portions represent the amendments.)

4) Foremost, when reviewing Document 7 (JP2002-206103) which the Examiner indicated as describing the same purity and impurities, descriptions relating to hafnium are in Example 2 of Document 7, and the analysis after refining is shown in Table 4. According to this Table, although the content of sulfur and phosphorus is within the scope of the present invention, the zirconium content is 2400wtppm; that is, 0.24wt%, and is clearly different from the content of 0.1wtppm or less of the present invention.

Further, Table 4 does not show the analysis of oxygen. Since hafnium is an element having a strong affinity with oxygen, it is extremely difficult to reduce oxygen from this element. Generally, although the indication is sometimes omitted when it is a minor component where analysis is difficult, the oxygen contained in hafnium is not such a minor component where analysis is difficult, and rather exists in large amounts.

In Table 4, although gas components are excluded, this should be considered that such exclusion is based on the fact that such gas components are often handled as being harmless even if they are included in large amounts. Nevertheless, the oxygen contained in hafnium is not something that can be overlooked.

Although Table 3 provides a description of gas components regarding the raw material, and the oxygen content is 500ppm. As described above, oxygen is an impurity that has a strong affinity with hafnium and is difficult to be reduced. The electron beam melting described in Document 7 will hardly reduce oxygen. Therefore, there is no choice but to say that the probability of the oxygen content being a numerical figure of roughly 500ppm is extremely high.

Incidentally, in the present invention, Applicant would like to add that molten salt is used for reducing oxygen, and not electron beam melting.

A major object of the present invention is to reduce oxygen, and this is a significant constituent element. In other words, Document 7 is clearly different from the description of "oxygen content of 40wtppm or less" prescribed in claim 1 of the present invention.

Accordingly, the invention of claim 1 and the invention of Document 7 are not the same, and Document 7 does not even provide the concept of the present

invention, and there are no grounds for indicating that the present invention could have been devised based on Document 7.

5) Next, the Examiner is stating that the invention pertaining to claims 1 to 4 lacks inventive step based on Documents 1 to 8, and, as the reason for this, the Examiner is stating that Documents 1 to 3 and 7 describe the implementation of electron beam melting for reducing oxygen upon manufacturing high purity hafnium. Nevertheless, the disclosure of hafnium in Document 1 (JP2002-105552) is the analysis of hafnium purity after performing electron beam melting of Example 2 and Table 4. The disclosure describes the zirconium content to be 3500ppm and the oxygen content to be 120ppm in the high purity hafnium after being reduced, and there is no analysis regarding sulfur.

In other words, there is a significant gap between the purity of high purity hafnium of the present invention in which the content of sulfur and phosphorus is respectively 10wtppm or less, and the zirconium content is 0.1wt% or lower and the purity of high purity hafnium of Document 1, and there are no grounds for indicating that the present invention could have been devised based on Document 1.

6) Next, with respect to Document 2 (JP4-358030), this also relates to technology of electron beam melting. Although Document 2 is placing titanium, zirconium and hafnium on the same level, the invention actually relates to titanium. Most of the descriptions relate to titanium, and, although there is an ethically disoriented description such as "similar effects can be obtained with zirconium and hafnium", there is no way that similar effects can be obtained. The credibility of descriptions in Document 2 is in itself problematic.

Hafnium of the present invention prescribes the zirconium content, which was extremely difficult to eliminate conventionally, to be 100ppm or less, and further prescribes the oxygen content to be 40wtppm or less. Document 2 has no concept of reducing the zirconium contained in hafnium.

Further, it is necessary to note that it is difficult to eliminate the oxygen contained in hafnium with electron beam melting. Moreover, Document 2 also fails to solve the problems of phosphorus and sulfur. Therefore, it would be clearly erroneous to use Document 2 as grounds for indicating that the present invention could have been easily devised based thereon.

7) Next, with respect to Document 3 (JP7-316681), although a part of the Description lists Ti, Zr, Hf, Nb, Ta, W and Mo, most of the descriptions relate to

zirconium, and there are no specific examples of hafnium.

Therefore, even with this Document 3, there is no description of making the zirconium content, which was extremely difficult to eliminate conventionally, to be 100ppm or less, and further making the oxygen content to be 40wtppm or less.

Further, with electron beam melting, plasma melting and vacuum arc melting, oxygen contained in hafnium can hardly be reduced. So as long as an invention is premised on electron beam melting, plasma melting and vacuum arc melting, there is no resemblance with the present invention. Moreover, Document 3 also fails to solve the problems of phosphorus and sulfur. Therefore, it would be clearly erroneous to use Document 3 as grounds for indicating that the present invention could have been easily devised based thereon.

8) With respect to Document 7, since the explanation in 4) above indicated that the technology is clearly different from the present invention, the description of Document 7 is omitted.

As evident from the foregoing explanation, Documents 1 to 3 and 7 clearly have different objects with respect to performing electron beam melting for reducing oxygen upon manufacturing high purity hafnium, and, even if electron beam melting is performed, it is not possible to obtain high purity hafnium capable of satisfying the requirements of the present invention.

Therefore, it would be clearly erroneous to use Documents 1 to 3 and 7 as grounds for indicating that the present invention could have been easily devised based thereon.

9) Further, as described in Documents 4 to 6, it is public knowledge to perform deoxidation with molten salt for reducing oxygen in titanium, and, since titanium, zirconium and hafnium have extremely similar physical and chemical characteristics, it would be easy for those skilled in the art to add the process of deoxidation with molten salt for reducing oxygen to the manufacture of high purity hafnium in Document 1-3 and 7 so as to reduce the oxygen content to be 40wtppm or less. Nevertheless, this indication is erroneous.

The logic of premising Documents 1 to 3 and 7 to be the manufacture of high purity hafnium is in itself erroneous, so this line of argument cannot be established. Further, to apply deoxidation of titanium with molten salt to the hafnium of the present invention is also a problem.

10) Document 4 (JP2003-193150), Document 5 (JP4-99829) and Document 6

(JP2000-345252) do in fact describe the deoxidation method of titanium with molten salt. If it is indeed true that "titanium, zirconium and hafnium have extremely similar physical and chemical characteristics", then why is there no publicly known technology relating to the deoxidation method of hafnium with molten salt? There is a significant reason for this.

The reason for this is that electrodeposited hafnium subject to molten salt electrolysis is extremely brittle, and will not become a lump even when pressed. This point is clearly different from the physical property of titanium, since titanium can be pressed easily. In other words, titanium and hafnium are "similar but different substances" with respect to this point.

The formation of a lump via pressing is important, and, when performing electron beam melting, there is a troublesome issue in the manufacturing process of having to form the material into a block shape. Further, electrodeposited hafnium contains large amounts of volatile gases (Na, K, Cl and so on), and there is a problem in that splash will occur and deteriorate the production yield. Thus, conventionally, in substance, hafnium has been manufactured with plasma arc melting and not electron beam melting. Therefore, if it is common knowledge to perform molten salt electrolysis regarding hafnium, it is necessary to present documents disclosing such fact. So as long as there is a problem in differentiating hafnium from titanium as described above, the foregoing is a requisite condition.

Upon manufacturing high purity hafnium, the reason the present invention adopted molten salt electrolysis is because it is necessary to reduce oxygen contained in hafnium as much as possible, and this is based on the discovery that the manufacture employing molten salt electrolysis, which was conventionally denied, is the most favorable method. Therefore, disadvantageous points exist as a matter of course. This means that, unlike titanium, it is not possible to easily create an ingot for electron beam melting via pressing. Nevertheless, so as long as there is an object of manufacturing high purity hafnium, even with the foregoing disadvantages, the present invention is the optimum method that did not exist in conventionally technology.

As the specific means for performing electron beam melting, the method of wrapping pulverized hafnium material with volatile copper foil or zinc foil, and subjecting this to electron beam melting was adopted. Although this is troublesome, since the oxygen contained in hafnium cannot be eliminated with electron beam

melting, molten salt electrolysis was performed to eliminate such oxygen, and then electron beam melting was further performed.

This is not disclosed anywhere in Documents 4 to 6, nor is there any such concept described therein. Therefore, it would be clearly erroneous to use Documents 4 to 6 as grounds for indicating that the present invention could have been easily devised based thereon.

11) Document 8 (JP2003-306728) is cited to indicate the use of solvent extraction in the refining of hafnium. Document 8 is technology for separating hafnium from zirconium and improving the purity of zirconium, and is describing technology that is entirely the opposite of the present invention. Thus, Document 8 is an inappropriate document. Regardless, Document 8 goes no further than disclosing just this point.

In other words, Document 8 provides no description regarding "a hafnium sponge raw material is subject to solvent extraction and thereafter dissolved, the obtained hafnium ingot is further subject to deoxidation with molten salt and electron beam melting was further performed". Even if zirconium could be separated from hafnium to a certain degree, the problem of eliminating oxygen existing therein is not disclosed anywhere in Document 8.

Therefore, even when combining Document 8 to Documents 1 to 7, the present invention could not have been easily devised based on these documents.

12) Accordingly, although numerous Documents 1 to 8 have been presented as materials for denying the inventive step of the invention of the present PCT application, these documents do not disclose the present invention, and cannot be used as grounds for denying the present invention. We are of the opinion that the invention described in all amended claims possesses novelty and inventive step. Therefore, Applicant kindly requests the Examiner to judge that the present invention possesses patentability.